Germany.—Deutsche Seewarte. Stiller Ocean. Ein Atlas von 31 Karten, die physikalischen verhältnisse und die Verkehrsstrassen darstellend, mit einer erläuternden Einleitung und als Beilage zum Segelhandbuch für den Stillen Ocean. Herausg. von der Direktion. Hamburg. 1896. Quer-Folio. 14 S. Text und 31 karten in Farbendruck.

Germany.—Jahresbericht des Physikalischen Verines zu Frankfurt a. Main. 1893-1894. Frankfurt. 1895. 8vo.

Enthält eine Studie.—Gewitter am 30 Dec. 1894. Von J. Zeigler und W. König (57-66 M. 1 Taf.)

Germany.—Die Magnetische Deklination und ihre Säkular Veränderung für 48 Beobachtungsörter, berechnet als periodische Funktion für jeden einzelnen ort aus den daselbst angestellten Beobachtungen. Nova Acta der K. Leop-Carol. Deutschen Akademie der Naturforscher. Bd. LXIII. Nr. 3. Halle. 1895. 4to. 87 s.

Germany.—Schmidt, A. Mittheilung über eine neue Berechnung des Erdmagnetischen Potentials. München. 1895. 4to. 66 s. S.-A. Abh. d. Bayer. Ak. d. Wiss. II cl. Bd. XIX. 1, Abth.

Ahlborn, Dr. F. Zur Mechanik des Vogelfluges. Demy. 4to. 134 pp. Hamburg. 1896.

Weisner, J. Beiträge zur kenntniss des tropischen Regens. 8vo. 38 s. S.-A. Sitzb. d. Ak. Wiss. Bd. CIV. Abth. 1. 1895.

Italy.—Osservazioni Meteorologi che fatte nell' anno 1894 all' Osservatorio della R. Universita di Torino. Calcolate dall dott. G. B. Rizzo. 58 pp. 8vo. Torino. 1895.

Mexico.—G. Herdia, S. J. Observatorio Meteorologico del Colegio de San Juan Nepomuceno. Saltillo. Mexico. Observaciones Meteorologicas practicadas durante el año de 1895. 4to. 27 bl. Saltillo. 1896.

Netherlands.—W. Van Bemmelen. Allgemeine Graphische Dastellung der Säkular Variation der Erdmagnetischen Deklination. 4 s. 4to. Eine Photographisch Reproducirte Karte. Utrecht. 1895.

Norway.—H. Mohn. Klima-Tabeller for Norge. 1 Luftens Temperatur. Kristiana. 1895. So. 27 s. S. A. Videns Kabsselk. Skrifter. Math.-Naturw. Kl. 1895. Nr. 10.

Portugal.—Annals do Observatorio do Infante. D. Luiz. 1891. Vol. XXIX. Fol. 139 pp. Lisboa. 1894. Same for 1892. Vol. XXX. Fol. 139 pp. Lisboa. 1895.

Spain.—R. Pardo de Figuerva. Compensación de declinaciones Magneticas en la Peninsula Ibérica. 87 P. 2 Pl. 1 Chart. Large 8vo. Madrid. 1895.

Sweden.—Iakttagelser under en ballongfärd den 4 August, 1894. Bih. t. k. Svenska Vet. Akad. Handl. Band 21. Afd. 11, No. 3. 8vo. 13 pp. 3 tables. Iakttajelser under en ballongfärd den 29 November, 1894. Bih. Band 21. No. 5. 8vo. 20 pp. 3 tables. Stockholm. 1895.

Switzerland.—A. Wolfer. Zur Bestimmung der Rotationszeit der Sonne. Mit einer Tafel. 8vo. 15 pp. Zurich. 1896. Separatabdruck aus der viertel- Jahrsschrift der Naturforschenden Gesellschaft in Zurich. Jahrgang XLI. 1896. Jubelband.

United States of America.—U. S. Department of Agriculture, Weather Bureau, Bulletin No. 16. The Determination of the Relative Quantities of Aqueous Vapor in the Atmosphere. L. F. Jewell. 8vo. 12 pp. 4 tables. 1 Spectrum of Rain Band. Washington. 1896.

United States of America.—U. S. Department of Agriculture, Weather Bureau, Bulletin No. 19. A. J. Henry. Report on the Relative Humidity of Southern New England and other Localities. 8vo. 23 pp. 4 charts. Washington. 1896.

United States of America.—U. S. Department of Agriculture, Weather Bureau. Instructions for use with the Rain Gauge. Circular C. Instrument Room. Revised Edition. 8vo. 11 pp. Washington. 1895.

Texas Climate and Crop Service.—Special Bulletin No. 8. Report on the Tornadoes of May 12 and 15, 1896, in Northern Texas. Isaac M. Cline, M. D. 8vo. 3 pp. 3 charts. Galveston, Texas. 1896.

United States of America.—Third Annual Report of the North Dakota Weather Service for 1895. B. H. Bronson, Director. 8vo. 96 pp. Jamestown, N. Dak. 1896.

United States of America.—Hydrographic Office. Sunrise and Sunset Tables. Showing the local mean time of the sun's visible rising and setting for each degree of latitude between 60° North and 60° South, and for each degree of the sun's declination. Computed by Ensign George Wood Logan, U. S. N. No. 111. 4to. 24 pp. Washington. 1896.

United States of America.—Contributions to Terrestrial Magnetism, the Variation of the Compass. U. S. Hydrographic Office. G. W. Littlehales. No. 109. 53 pp. 8vo. Washington. 1895.

United States of America.—Observations of the New England Weather Service. 1894. 4to. (Annals of Harvard Coll. Obs. Vol. XLI, No. III. Pages 63-93. 1 table.)

Marvin, C. F., Prof.—Cloud Observations and an improved Nephoscope. Reprinted from the Monthly Weather Review of January, 1896. 8vo. 12 pp. Washington. 1896.

Marvin, C. F., Prof.—The Marvin Seismograph. Extract from Monthly Weather Review, July, 1895. 8vo. 6 pp. Washington. 1895.

Russel, Israel C.—The Lakes of North America. A Reading Lesson for students of Geography and Geology. 8vo. 125 pp. 23 pls. 8 figs. Boston. 1895.

Rotch, A. L.—Observations made at the Blue Hill Meteorological Observatory, Mass., in 1894, with an appendix containing anemometer comparisons. Cambridge. 1895. 4to. (Annals of the Astr. Obs. of Harvard College, vol. XL, part IV. Pages 211-300. 3 tables.)

Taber, C. A.—The Cause of Warm and Frigid Periods. 8vo. 80 pp. Boston. 1894.

Wright, G. Frederick, D. D.—Greenland Icefields and Life in the North Atlantic. 12mo., with maps and illustrations. New York. 1896.

Wallace, A. R.—The Ice Age and its Works. 8vo. Washington. 1894.

Nipher, F. E.—Electricity and Magnetism; a Mathematical Treatise for Advanced Undergraduate Students. Small 8vo. pp. xi–426. St. Louis, Mo. 1895.

Carpenter, Rolla C., Cornell University.—Heating and Ventilating Buildings. 400 pp. New York. 1895.

KITE EXPERIMENTS AT THE WEATHER BUREAU.

By C. F. MARVIN, Professor of Meteorology, U. S. Weather Bureau.

[Continued from the May REVIEW.]

FORMS AND CONSTRUCTION OF THE WEATHER BUREAU KITES.

[Continued.]

Characteristics of wing surfaces.—The cross-section of the wings of birds presents characteristics that are very different, as a rule, from those of a section of the surfaces ordinarily employed in kites. As wings are evidently highly efficient sustaining surfaces, we may do well to analyze their form carefully and inquire to what extent and in what respect those forms may be copied with advantage in constructing kites. Aside from the arched form commonly characteristic of wings and which in the same wing probably varies more or less in amount with changes of pressure, we observe that the front edge is firm, rigid and thick, and that the wing becomes thinner and more flexible towards the rear edge, which is elastic and quite pliable under comparatively feeble forces. Much has been written concerning the advantages of these peculiarities by some who have sought to solve the mysteries of the sailing flight of large birds.

Without entering here into a detailed analysis of the action of the wind pressure upon a wing and its reaction thereto, I am convinced that the peculiar usefulness various writers seek to attribute to every detail of the wing structure is very much exaggerated and overdrawn. At least grave errors and misconceptions have resulted because a sharp distinction has not been drawn between the essentially different use of its wings made by the bird when employed in gliding or sailing flight on fixed wings, as contrasted with flight by flapping the wings.

The action of the wind upon the wings of sailing birds is similar in several respects to the action of wind upon kites whereas, nothing in the action of ordinary kites resembles the wing-flapping of birds. Therefore, whatever qualities of wing surfaces are of special advantage in sailing flight may also be of advantage in kite surfaces. By far the most important of these is the arched character of wing surfaces, the advantages of which have already been noticed. In addition to this we observe that the wing is thick on the front edge. It seems hardly possible that any other consideration than that of strength alone can determine what this thickness should be. If nature could make a wing of adequate strength but yet with a smaller sectional area, she would do so, and we believe it would serve the bird better. Again, the wing is also flexible so that the amount of curvature of its arched surface changes with different pressures. We are disposed to regard this as purely an incidental result. To have made a perfectly rigid wing, nature would have been obliged to make a heavier wing, which would be to the bird's disadvantage. The flexible wing is lighter, but yet of ample strength to resist the strains it may be called upon to bear. Although it can be shown that in wing-flapping-flight a slight advantage results from some flexibility, yet the same can not be shown to obtain to any important degree in sailing flight. We are forced, therefore, to the conclusion that for sailing flight the flexibility is an incidental quality. Finally, the thin, very flexible, feathers of which the rear edge of the wing is composed are believed to serve specially useful purposes in wing-flapping movements; but for sailing flight, in which the wings are set at comparatively small angles of incidence, if there is any special merit in the characteristics of the rear edges at all, it is not to any appreciable extent due to their flexibility, but rather to the fact that the streams of air flowing over the upper and under surfaces are able to unite into one stream which is not broken up into objectionable eddies and whirls.

Kites with wing-like surfaces.—Grave constructional difficulties are encountered in giving to the sustaining surfaces of kites those qualities that we have pointed out as being advantageous in the wings of birds. In one of the kites framed in accordance with the improved plan of construction described in the WEATHER REVIEW for May (page 164), the cloth was left free at the rear edge in order that the surface might be thin and pliable, like the rear edge of a bird's wing. This was accomplished by omitting the rectangular frames ordinarily forming the rear edges of the cells. The behavior of this kite in the air was, on the whole, very satisfactory. Nevertheless, the cloth formed into waves and fluttered to a greater or less extent, much as other kites having free edges of cloth had done. The kite was accidentally broken and the line of experiment was not carried any further. The dimensions of the kite are given in Table VI, No. 21.

Improved kite with arched surfaces.—Arching the sustaining surfaces of the improved kite is a matter of great simplicity. The cloth is simply left just a little slack between the two frames. Even when the cloth is fitted tight it will still arch upward to some extent when exposed to wind pressure. To make the depth of the arch about one-twelfth the cord requires, however, a slight looseness of the cloth between the frames. Thus far, I have made no effort to extend the arched effect to the side edges of the kite. The connecting sticks between the frames are straight. As a result the arched effect is most pronounced in the middle portion, gradually diminishing as the sides are approached, where it practically disappears It is thus seen that in this kite the arched form of the surfaces can be secured without any additional material. When the first kite made of this form was flown in a moderately fresh wind the longitudinal truss was completely broken in two within ten seconds from the time the kite was launched. The break occurred at the point of attachment of the bridle and was caused, it is believed, primarily by the relatively greater pulling power of the arched surfaces. A very similar kite of greater area and with seemingly a more frail longitudinal truss was flown immediately afterward in fully as strong gusts of wind, but with no mishap whatever. When the broken truss was replaced by a stronger one the kite was flown with remarkable success in very light winds. In fact this kite flew when the wind was too light to sustain other cellular kites. Up to the first of July, however, no real test of the kite with arched surfaces had been made, owing to the lack of favorable opportunity.

Modified longitudinal truss.—When the truss is run through the inside of the cells, in the manner heretofore described, the slack cloth on the lower sustaining surfaces of the cells is partly prevented by the lower rib of the truss from forming the most effective arched surfaces. To avoid this difficulty the bottom stick of the longitudinal truss is arranged to come outside the cell, as shown in Fig. 57, which gives also the principal dimensions of the kite referred to in the foregoing remarks.

Other improved kites.—While the writer was engaged in developing and perfecting the construction of kites by means of the rectangular frames already described, Mr. Potter was working up certain modified forms of the cells. These were trapezoidal in form, rather than rectangular. In the first kite made each cell was provided with three, instead of two, sustaining surfaces. Long struts were used for spreading out the cloth surfaces. This involved cutting a rather large slotted hole in the middle surface of each cell to permit the passage of the diagonal struts. As a whole, the three-plane feature of this kite was not altogether satisfactory and was abandoned and a better kite constructed with simply a trapezoidal cell. This is shown in Fig. 58. The cell is spread by simply two long diagonal struts, instead of the four employed in the original Hargrave rectangle. This construction, with two long diagonal struts, was afterwards used for rectangular cells, also, and is recommended in preference to that shown in Fig. 50.[1]

Points of advantage.—As already mentioned, the arrangement of struts adopted in the trapezoidal cell simplifies the construction considerably, with a slight gain in lightness at the same time. The side surfaces being set inclined considerably to the vertical contribute in a slight degree as sustaining surfaces. The weight of the kite per unit area is rather less than that of the rectangular cell of the same size. There is nothing to prevent the cloth from fluttering, and the struts crossing within the interior of the cell offer some obstruction to the free flow of air through the cell. The oblique position of the side planes causes them to shelter in a slight degree the outer ends of the top surfaces, and it is believed there are more pronounced eddy effects in these corners than in the case of a cell of strictly rectangular form. The kites of this form appear to be the most steady and stable of any employed.

This form of kite is easier to make than kites of the frame construction, but although the latter are heavier the tests show they are superior, as will be brought out in a later section of this article, describing the results obtained.

The form of construction adopted in the trapezoid cell was also employed in making the rectangular cells. Prior to July 1 exact tests of the relative merits of the two forms had not been made, owing to the lack of favorable winds.

The Weather Bureau Kites.—Table VI contains a schedule of the dimensions, weights, etc., of the greater part of the kites employed in the Weather Bureau experiments made between December 1, 1895, and July 1, 1896. Considerable care has been expended in the preparation of this table in order to give full and accurate information concerning every important element. In comparing the results obtained with kites of different form, and with different kites of the same form, the weight per unit of sustaining area is a most important desideratum. The weights of the finished kites were therefore always determined with care and are given in the table. It is strongly recommended that other experimenters, when publishing results of their work, be careful to give accurate data respecting the weight and the actual sustaining surface, so that a proper basis for comparison may be had. It will generally be best to give the total weight, rather than the weight per unit area, because the *effective* sustaining surface may not always be the same as the *apparent* sustaining surface. For

[1] Fig. 50 will be found in the Weather Review for May, 1896.

example, a Malay kite 5 feet high and 5 feet broad appears to have a surface 12.5 square feet. When made in the usual way and with the cloth moderately taut, the lateral surfaces form a flat angle with each other, somewhat as shown in Fig. 34[1].

The angle at $C\ E\ D$ may sometimes be as much as 30° less than two right angles, and in such a case the sustaining effect of the 12.5 square feet will be no greater than that of about 12.1 square feet of surface not bent backward. Therefore, the true weight per unit of sustaining area in such a kite will be the total weight divided by 12.1 rather than 12.5. In other forms of kites more marked differences may arise. Some systematic method is therefore needed for accurately computing the effective sustaining surfaces of kites of different forms.

TABLE VI.—*Dimensions of Weather Bureau kite.*

Serial number.	Kind or shape of cell and material of covering.	Number.	Width of kite.	Height of cell.	Width of cloth bands.	Length of kite.	Actual surface of cloth.	Effective sustaining surface.	Total weight.	Weight per sqr. ft. sustaining surface.
			Ins.	*Ins.*	*Ins.*	*Ins.*	*Sq.Ft*	*Sq.Ft*	*Lbs.*	*Lbs.*
1	Rectangle, by struts, calico..	1	48	24	24.0	72	48.0	32.0	....	......
2	Malay, silk........	....	68	....	......	60	16.2	......	....	......
3	Diamond, silk........	3	34	13	8.5	28	9.9	8.6	0.392	0.046
4	Kite, Fig. 41, cambric........	1	80	....	9.0	54	16.2	14.6	2.51	0.172
5	Diamond, nainsook........	1	65	22	18.0	60	32.5	29.0	2.14	0.074
6	Diamond, 5 cells, cambric....	1	65	18	8.5	78	37.9	35.3	....	......
7	Hunter, wing kite, muslin...		40	16	14.6	48	16.3	13.8		
	Each wing........	1	23	....	......	40	3.2	3.2	1.55	0.077
	Total........		....	....	......	......	27.2	20.2		
8	Kite, Fig. 42, cambric........	1	33	....	15.0	45	26.5	......	....	......
9	Diamond, cambric........	3	48	21	15.0	54	20.0	16.8	1.25	0.074
10	Diamond, 3 cell, cambric.....	1	48	21	15.0	93	30.0	25.2	....	......
11	Diamond, silk........	5	40	17	13.0	43	14.4	12.0	0.91	0.076
12	Diamond, cambric........	1	40	17	13.0	43	14.4	12.0	1.20	0.100
13	Winged kite, silk........		40	17	13.0	43	14.4	12.0		
	Each wing........	1	23	....	......	43	3.5	3.5	1.14	0.067
	Total........		...	....	......	......	21.4	17.0		
14	Wing kite, cambric........		48	17	15.0	45	24.0	21.2		
	Each wing........	1	48	...	......	60	12.0	12.0	2.31	0.051
	Total........		....	....	......	......	48.0	45.2		
15	Silk kite, cambric wings.....		40	17	13.0	43	14.4	12.0		
	Each wing........	1	38	....	......	64	8.4	8.4	1.51	0.039
	Total........		....	....	......	......	31.2	28.8		
16	Hunter, cylinder kite, Fig. 48.		27	27	23.0	60	26.5	.....		
	Muslin, each wing........	1	34	....	......	60	7.0	7.0	8.12	......
	Total........		....	....	......	......	40.5	.....		
17	Diamond, cambric........	2	48	17	15.0	45	24.0	21.2	1.54	0.073
18	Diamond, cambric........	1	60	24	15.0	45	32.0	27.1	1.98	0.073
19	Rectangle, by struts, nainsook........	1	48	18	17.6	54	32.3	23.5	2.08	0.088
20	Rectangle, by frames, cambric........	1	48	16	19.0	52	33.7	25.3	2.43	0.096
21	Rectangle, one frame per cell, cambric........	1	51.5	14	15.0	60	27.3	21.5	2.21	0.103
22	Rectangle, 3 planes, cambric, Fig. 56........	1	48	21	19.2	78	49.6	38.4	3.54	0.092
23	Ditto, reconstructed, with but two planes........	1	48	21	19.2	74	36.8	25.6	3.22	0.126
24	Ditto, with 3 planes........	1	48	21	19.2	74	49.6	38.4	3.89	0.102
25	Trapezoid, 3 planes........	1	...	....	......	......	......	......	....	......
26	Rectangle, by frames, paper..	1	60	13	19.2	60	39.2	32.0	....	......
27	Rectangle, by frames, cambric........	1	48	16	19.0	65	33.7	25.3	3.04	0.120
28	Trapezoid, nainsook {top.... / bottom}	1	84 / 48	24	20.0	78	53.3	43.1	4.49	0.104
29	Trapezoid, nainsook {top.... / bottom}	1	80 / 48	24	18.0	54	46.4	36.7	3.06	0.083
30	Rectangle, by frames, cambric........	1	60	20	19.2	70	42.7	32.0	3.59	0.112
31	Rectangle, by frames, cambric, cloth arched........	1	60	13	19.2	76	39.2	32.0	3.34	0.104
32	Ditto, reconstructed........	1	60	13	19.2	76	39.2	32.0	3.52	0.110
33	Rectangle, by struts, nainsook........	1	48	21	20.0	72	38.3	26.7	2.80	0.105
34	Diamond, cambric........	1	30	13	9.6	33	8.0	6.6	0.374	0.057
35	Trapezoid, nainsook {top.... / bottom}	1	28 / 20	9	9.0	30	8.5	6.4	0.407	0.063
36	Rectangle, by frames, cambric........	1	60	20	19.2	60	42.7	32.0	3.83	0,120

Explanation.—"Rectangle by struts," designates that the cell is a rectangle, and the form is given by means of a set of struts, such as shown in Figs. 50 or 59. "Rectangle by frames," designates that the rectangular cell is constructed as explained in connection with Figs. 51 to 55. The width of the kite is the crosswise dimension of the kite, that is, the dimensions at right angles to the direction of the flow of air over the surfaces. In the case of the diamond kites, the width is not measured from side to side in a straight line, but along the surface of the cloth. The width, therefore, represents one-half the perimeter of the cell. An idea of weight of the framework in the different kites may be obtained by comparing the weights per square foot of surface, with the following weights of materials employed in the covering:

	Pounds.
Weight of silk per square foot........	.0084
Weight of nainsook per square foot........	.0126
Weight of cambric per square foot........	.0187
Weight of muslin per square foot........	.0220

Bridle.—It was impossible to specify within the limits of the table the arrangement of the bridle on each kite. This was often changed with each experiment and will receive consideration hereafter.

True and apparent angle of incidence.—Such a systematic method may be had by always taking account of the true angle with which the wind impinges against a surface in question. The distinction between the terms the *true angle of incidence* and the *apparent angle of incidence* will be understood from Figs. 60 and 61. With such a kite as shown in Fig. 60, the surface is flat and continuous, the angle which the wind makes with the midrib of the kite, when flying normally, is clearly also the true measure of the angle with which the wind impinges upon the surfaces themselves. In this case, therefore, the angle $A\ O\ W$ is the *true angle of incidence.* If, however, the surface is bent backward across the midrib so as to form a dihedral angle, the kite will then appear as shown in Fig. 61. It is plain in such cases that the angle between the wind and the midrib is not the same as the angle between the wind and the planes themselves. Inasmuch as the angle between the wind direction and the surfaces themselves can not easily be measured directly, we will generally prefer to measure the angle between the wind and midrib (or some similar longitudinal axis of the kite) as *representative* of the true angle of incidence. In those cases in which the angle between the wind and midrib is not the same as the true angle of incidence of the wind, the former angle, that is, the angle $A\ O\ W$, will then be called the *apparent angle of incidence.*

It will be readily understood by those familiar with geometric principles that the true angle of incidence of the surfaces in such a case as represented in Fig. 61 will be the angle $A'\ O'\ W'$. $A'\ O'$ is the line formed on the kite surfaces by the intersection of a plane through $W'\ O'$ and perpendicular to the kite surface. It can be shown without difficulty that the angle $A'\ W'\ E'$ will always be the same as the amount by which the planes are bent backward, that is, it is the same as the angle $E\ D\ C$. The relation between the real and apparent angle of incidence may be found as follows:

Let $b =$ the angle $A'\ W'\ E' = E\ D\ C$.
Let $i =$ the *real* angle of incidence of the wind $= A'\ O'\ W'$.
Also let $a =$ the apparent angle of incidence $= W'\ O'\ E'$.

Then, by trigonometry—

$$\frac{W'\ O' \sin. i = A'\ W'}{W'\ O' \sin. a = E'\ W'} = \cos. b.$$

$$\therefore \sin. i = \sin. a \cos. b.$$

The angle b, as we have stated, is the amount by which the planes are bent backward, and therefore is always known, or can be found.

When comparing, for example, two such kites as the diamond cell and the rectangular cell, shown in Figs. 40[2] and 50,[2] it is plain that when the midribs are set at the same angle in the air, the surfaces of the rectangular cell kite are inclined at a greater angle to the wind, and therefore experience a greater wind pressure than those of the diamond cell kite, shown in Fig. 40. To make a fair comparison between the kites, some allowance must be made, in the case of the

[1] Fig. 34 will be found in the Weather Review, April, 1896.

[2] Figs. 40 and 50 will be found in the Weather Review for May.

diamond cell kite, for the slighter inclination of its surfaces. Similarly, in the trapezoidal kite, shown in Fig. 58, the side surfaces act as sustaining surfaces to some extent. We can compute the amount of this by the aid of the equation given above, as will be hereafter explained.

To make the proper allowance for different inclinations, we must know how much greater the pressure is at one inclination than at another. Different experimental researches have given different results on this point. Chanute,[1] after a critical analysis of all available data, has concluded that Duchemin's formula is probably the most accurate representation we have of the law of variation of pressure, with changes in the angle of incidence. This law, however, is strictly applicable only to plane surfaces. The law for curved surfaces is known to be very different from that for flat surfaces. As yet, however, no satisfactory statement of this law for curved surfaces has been formulated, so far as known to the writer. Since the surfaces are sensibly flat in most of the cellular kites described in Table VI, and as the angles of incidence of the surfaces in different kites will all fall within 15° of an average inclination, the use of Duchemin's formula will answer every purpose for the present.

If the pressure on a given plane surface placed normal to the wind is regarded as 100, then the percentage pressure, P, on the same surface inclined to the wind at an angle, i, will, by Duchemin's formula, be—

$$P = \frac{2 \sin. i}{1 - \sin.^2 i} 100.$$

The relative pressure upon inclined surfaces is of such importance in connection with the kite problem, that the value of P for such angles of inclination as are likely to occur in kite work are extracted here from Chanute's larger table:

TABLE VII.—*Proportional pressure on inclined flat surfaces.*

Inclination.	Proportional pressure.	Inclination.	Proportional pressure.	Inclination.	Proportional pressure.
°	%	°	%	°	%
1	3.5	11	36.9	21	63.7
2	7.0	12	39.8	22	65.7
3	10.4	13	43.1	23	67.8
4	13.9	14	45.7	24	70.0
5	17.4	15	48.6	25	71.8
6	20.7	16	51.2	26	73.7
7	24.0	17	53.8	27	75.2
8	27.3	18	56.5	28	77.1
9	30.5	19	58.9	29	78.6
10	33.7	20	61.3	30	80.0

In order to allow for the dissimilar conditions of the surfaces of the several forms of kites the effective sustaining surface for each kite has been computed on the basis that the midrib or longitudinal axis of the kite makes an angle of 18° with the wind. Numerous measurements have shown that such an angle is roughly an average angle found in practice. In the case of a kite with cells of rectangular form it is plain that when the midrib is set at an angle of 18° to the wind the surfaces are also at the same angle, and no allowance is necessary. If, however, we consider the diamond cell we see that when the midrib is at 18° to the wind the surfaces are at a less angle, and we therefore rate the kite as if its area was less in the same proportion as its lifting power is lessened by the slighter inclination of the surfaces. This is further elucidated by an example. Kite No. 17, of Table VI, is a diamond cell kite in which the cloth surface is actually 24 square feet. From the tabulated dimensions of the kite we find that the angle by which the surfaces are bent backward from a flat surface is—

$$b = 20.7°$$

Assuming the apparent angle of incidence to be 18°, that is, $a = 18°$, we will have for the true angle of incidence—

$$\sin. i = \sin. 18° \times \cos. 20.7° = 0.2890$$
$$\therefore i = 16.8°$$

That is, when the midrib of this kite is inclined to the wind at an angle of 18° the surfaces are inclined at an angle of 16.8°. From Table VII the pressure on a unit area of surface at 18° is 56.5 per cent of the normal pressure, while upon the same area at 16.8° the pressure is 53.3 per cent of the normal. Multiplying the area of the kite by the ratio of the above pressures, we obtain—

$$24 \times \frac{53.3}{56.5} = 22.6 \text{ sq. ft.}$$

That is to say, the 24 square feet of surface in the diamond cell experiences a pressure, other things remaining the same, that is just equal to the pressure on 22.6 sq. ft. of sustaining surface on a flat surface kite, or, a kite with cells of the rectangular form.

We must notice further that the pressure on the inclined surfaces is not exerted upward, but is normal to the surface and assumes a laterally inclined direction, whereas, with surfaces not inclined in the manner under consideration, the pressure is exerted almost directly upward. These differences are shown in Fig. 62, which represents an end view of a trapezoidal cell. The pressure on the parallel surfaces may be represented by lines such as $O\ B$, $O'\ B'$, while on the side surfaces the pressure acts in the direction of the lines $L\ S$ and $L'\ S'$. The upward lifting effect of an inclined pressure, such as $L\ S$ will be represented by a line such as $L\ T$. In reality, the lines representing the effects mentioned above are not strictly in the plane of the paper, but are differently inclined thereto. We may, however, leave out of consideration as unimportant the effects arising from the lines being differently inclined to the plane of the paper, and, by doing so it results approximately that if P represents the pressure on a surface such as the side of the trapezoid, or the surface of a diamond cell kite, then the upward directed effect of this pressure will be—

$$\text{Upward pressure} = P \cos. b.$$

Where b, as before, is the amount the planes are inclined backward. From these considerations it follows that to ascertain the equivalent sustaining effect of the surfaces in the diamond kite, the proportional pressure on the inclined surfaces must be multiplied by the cosine of the angle we have called b. That is, in case of kite No. 17.

$$\text{Equivalent surface} = 24 \times \frac{53.3}{56.5} \cos. 20.7° = 21.3 \text{ sq. ft.}$$

In other words the effective sustaining surface of the kite in question is 21.2 square feet, which means that this kite with 24 square feet of actual surface (other things remaining the same) will pull the same as a kite with rectangular cells in which the total area of the top and bottom surfaces is 21.2 square feet.

In a similar manner we may determine the sustaining effect of the steeply inclined side surfaces in the trapezoid cell. In the kite shown in Fig. 58, the total area of the side surfaces is 16.7 square feet. The angle between the side and top surfaces is 53.1°, that is, $b = 53.1°$. Therefore, when the midrib of the kite is inclined 18° to the wind—

$$\sin. i = \sin. 18° \times \cos. 53.1° = .1854.$$
$$\therefore i = 10.7°.$$

That is, the true angle of incidence of the wind upon the side surfaces is 10.7° when the mid rib is inclined 18°. By means of the ratio of pressures we have—

$$16.7 \times \frac{35.9}{36.5} = 10.6$$

[1] Progress in Flying Machines.

That is, the total pressure on the 16.7 square feet is the same as the pressure on 10.6 square feet of the parallel surfaces of the kite. Introducing the further reduction necessary to resolve the pressure on the inclined surfaces to an upward directed pressure, we have—

$$10.6 \times \cos. 53.1^\circ = 6.36.$$

That is, the 16.7 square feet of inclined surfaces exercise' approximately, the same lifting effect as 6.4 square feet of the surface in the top and bottom planes of the cells. The total area of the top and bottom planes is 36.7 square feet. Adding to this the 6.4 square feet equivalent surface in the side planes, we have—

Total effective sustaining surface = 43.1 square feet.

The above computations are based on an assumed angle of incidence of the midrib of 18°. If some other angle, such as 12° or 25°, had been assumed, the result would still have been very nearly the same; and it will be found that it is not of great importance just what angle of incidence is assumed for the midrib. It is necessary only that some common basis of comparison be had for the several forms of kites.

General Results.—It is unnecessary to describe in detail the behavior and the comparative results obtained with the several kites described in Table VI. In the earlier part of our experiments appliances were not available, or had not been devised, by which the action of the kites could be critically analyzed and tested. The work consisted in flying the kites alone, or two or three in tandem to the highest attainable elevations, which were deduced from the known length of wire out, the measured angular elevation of the kite, and the inclination of the wire at the reel. Tests of this character are of very little aid in perfecting kites; about all that can be gained is a knowledge of the qualities of steadiness and general features of kite behavior, and added thereto a most valuable personal experience in the management of kites. In a subsequent section the methods of systematically analyzing the action of kites that were introduced later in the course of our experiments will be described.

Relative steadiness of kites.—The most perfectly made kite will never remain steady in one position for more than a few seconds at a time, but will always move about more or less, now rising or falling, swaying now to the right or left, now steady for a moment, etc. These constant changes in its position are directly caused by corresponding changes in the motion of the air itself. Above elevations of 600 or 800 feet, it will be noticed that a kite is always much more steady than for lower elevations, and it often happens that a kite which darts about violently near the ground flies quite steadily when 500 feet or more aloft. While the great and constantly recurring changes of the wind cause the irregular motions of the kite, yet the amount that a kite will move under a given change depends upon the nature of the kite itself. The cellular kites are all (I speak only of well made kites) much steadier than nearly flat single surface kites. Nevertheless, kites with cells of different proportions differ greatly in steadiness. Roughly speaking the greater the distance between the top and bottom surfaces of the cell the more stable and steady the kite. It was found that of the kites described in Table VI those were most steady in which the *total cloth surface* was relatively great, as compared with the *effective sustaining surface*. In the rectangular cells the side surfaces, under normal conditions, do not experience any sustaining pressure at all. These surfaces, however, act in the most beneficial way to prevent sudden and extreme sidewise movements of the kite. When a deep-celled rectangular kite experiences a sudden and momentary unequal distribution of pressure over its surfaces, the kite shifts its position much more slowly than a shallow-celled kite of the same kind. In many cases it no doubt happens that the sudden inequality of pressures disappears and equilibrium is restored before the kite has shifted its position by more than a part of the shifting which would have been required had not the kite been steadied by the action of the relatively considerable extent of side surfaces. Similar effects are brought about in diamond kites when the short, or vertical diagonal of the diamond is relatively great. In the kite specified under No. 22, Table VI, and illustrated in Fig. 56, the middle plane of each cell could be removed. The kite always flew much steadier without the middle planes than with them. Large kites are more steady than small ones. Large kites were also found to be relatively heavier than small ones. The greater steadiness is no doubt, in part, directly a result of the greater mass, but the large kite experiences the average pressure of a considerable mass of air, which average pressure is no doubt less irregular than the average pressure of the very small stream of air intercepted by a very small kite.

The foregoing remarks apply wholly to well made kites. The darting and irregular movements of a kite which is defective in some respect are similar to those of a well made kite. The experienced kite flyer, however, is soon able to perceive when the motions are different from those caused by the usual variations of the wind, and therefore that something is wrong with the kite. The cause of erratic behavior in a kite known to be of good form may generally be traced to some lack of symmetry. It often happens that the defect exists in a pronounced manner only when the kite is under strain by the wind. Some weakness of the frame permits distortion when the strain exceeds a certain amount, and when the strain is removed the kite may appear to be all right.

Relative weights of kites.—The last column of Table VI gives the weights of the kites per square foot of sustaining surface. It is seen that very small kites, such as Nos. 3, 34, and 35, may be very light, nevertheless are quite stanch and strong. It will be shown further on that these small kites, notwithstanding the seeming advantage in weight, are less efficient than larger and heavier kites. The relative effects of edge pressures, waviness, eddies, etc., is believed to be large in small kites.

The winged kites were also very light in some cases, but experiments showed that these kites were entirely too weak, except for very light winds and that the frame work must be much stronger than that employed in the wing kites tested. Experience showed that, in general, stronger framing was necessary and the weight of the rectangle and trapezoid kites is noticeably greater than that of the diamond kites. The efficiency of these heavier kites was, however, in spite of the weight, greater than that of any others tested. The records of highest efficiency were obtained from kites Nos. 23, 29, and 36, which are the heaviest constructed. A light kite, even though less efficient, will attain a steeper angular elevation in a light wind than a more efficient kite of greater weight, but when the wind blows hard the inefficient kite increases its angular elevation but little, while, on the other hand, the efficient kite in a strong wind soars up to a high angular elevation. Elevations of a mile or more cannot be attained unless there is plenty of wind, i. e., winds capable of producing pressures amounting to six or eight times the weight of the kite.

It is important that a clear idea be formed of the exact manner in which the weight acts as one of the forces that determine how high a given kite can fly. The effect of the weight under different conditions of wind force is brought out by the following consideration of the diagram of forces shown in Fig. 63. To avoid confusion of ideas and a complex diagram of lines, the drawing shows only the parallelogram of forces. We will also suppose for simplicity that the angle of incidence of the kite remains constant with different wind velocities. The line $A\ B$ is drawn parallel to the longitudinal axis of the kite and represents its inclination; $H\ N$ is a horizontal line; O is the point at which the lines of action of the wind pressure and gravity intersect. Let $O\ G$ represent the weight of the kite. (The weight of the better grade of kites in Table VI ranged between .09 and .12 pound per square foot of sustaining surface.) Let us suppose our kite weighs 10 pounds per square foot. Now, with a light wind of between 8 and 10 miles per hour experimental results show that the pressure per square foot of sustaining surface in ordinary kites will be barely twice as great as the weight per square foot. The line $O\ Q$, twice as long as $O\ G$, represents such a relation between these forces, and their resultant is a force represented by the line $O\ R$; $O\ H$ represents the direction the top end of the string must take. Under these conditions the kite on a short string can attain only a low angular elevation, represented by the angle $O\ H\ N$. If, however, the wind velocity were from 12 to 14 miles per hour, the pressure per square foot would be about double the former pressure. The conditions of equilibrium for such a case are given by the parallelogram $O\ Q'\ R'\ G$, and the string next the kite will take the direction $O\ H'$, which is very much steeper than its former direction, $O\ H$. It results, therefore, that the angular elevation of the kite has been greatly increased by only a small increase in the wind force. Let us next consider the effect of a still greater wind velocity, for example, 20 miles per hour. The pressure per square foot of surface for this velocity is fully ten times the weight of the kite per square foot. By constructing the parallelogram $O\ Q''\ R''\ G$, representing these relations, we locate the line $O\ H''$, which represents the direction of the string next the kite. The string in this case is only a little steeper than its former direction, $O\ H'$, notwithstanding that the wind pressure is considerably greater. With greater and greater wind pressures it will be found the direction of the string approaches closer and closer to the direction of the line $O\ M$, which represents the maximum possible steepness of the string. This degree of steepness could be attained if the weight of the kite were wholly inappreciable, or if the force of the wind were exceedingly great compared with the weight. From this analysis we see that in light winds the effect of the weight of the kite is very detrimental and causes the kite to fly at a low angle of elevation. The same result will follow with a heavy kite in a heavy wind. That is to say, whenever the wind pressure per square foot is only two or three times the weight per square foot the kite can then attain only a low angle of elevation. On the other hand, when the wind pressure per square foot is five or six times the weight per square foot the kite can take nearly its maximum possible angular elevation, and even though the wind pressures increase to fifteen or twenty times the weight, only a very slight increase in the angular elevation will result. The effect of such pressures is expended almost wholly in increasing the tension on the kite string.

On the choice of materials in the construction of kites.—Two very important and interesting problems are presented under this head, namely: (1) What materials are best suited for kite building? (2) How may a given material be used to the best advantage? To these questions full and complete answers can not yet be given, they can be brought out only as the result of actual tests and trials of many materials and many plans of construction. Nevertheless we may be greatly assisted in reaching the best results by a careful consideration of what is already known concerning the strength and resistance of ordinary materials and certain general methods of construction.

(1) *What materials are best for kites?*—Silk is probably the lightest material for covering or sustaining surfaces, but it is not very durable, and like all kinds of cloth it is more or less objectionably affected by rain and moisture. A cloth kite in the rain or in a cloud becomes heavier unless the material has been varnished or otherwise rendered waterproof. The fabrics employed in balloon construction are both waterproof and impervious to the wind, but they are considerably heavier than the ordinary unprepared cloth as is shown from the weights given in table VIII. Very light balloon fabrics are manufactured of silk but these are not of sufficient strength to use for kites without being reinforced with some sort of netting. If we turn from textile fabrics we find that sheet aluminum is apparently the best suited of metals for kite coverings. In kites of the usual size it will probably prove to be impracticable to use metal in sheets thinner than one-hundredth of an inch (equal to three thicknesses of this printing paper.) Sheet aluminum of this thickness weighs 0.1414 pounds per square foot; sheet steel of the same size weighs .408 pound per square foot, but it much stiffer. Let us see how a kite of aluminum or steel will compare, in weight, with a cloth and wood kite. Kite number 23, of table VI, is the heaviest one listed except number 4, which was unsatisfactory. Sheets of aluminum riveted together in the form of rectangular cells 48×21×19.2 inches would require additional material to make the cell rigid. Moreover a longitudinal truss is required to unite the cells. The wooden truss used in kite number 23 weighed just 0.664 pound, or at the rate of 0.0260 pound per square foot of sustaining surface. The aluminum kite would require a truss at least as heavy as this, and including the weight of the side surfaces of the cells but omitting any allowance for the additional framing required to stiffen the cells, the total weight of the metal kite with wooden truss would be 0.229 pound per square foot of sustaining surface as compared with a weight of 0.126 pound per square foot for the cloth and wood construction. If sheet steel were employed the weight of the kite would be 0.614 pound per square foot, still no allowance being made for framing required in the cells. These computations show clearly that these sheet metals can not be substituted for cloth in the construction of kites designed to attain great elevations. Very thin boards of white pine one-sixteenth of an inch thick would be a trifle heavier per square foot than the thin sheet of aluminum previously considered, and would probably require less framing to stiffen the cells. Such thin boards are likewise, however, too heavy for kite surfaces.

Aluminum wire gauze, the meshes of which are filled with elastic varnish, has been proposed for aerial planes. Such material is said to weigh from 0.094 to 0.250 pounds per square foot, according to the size of the wire and number of ends per inch.

Vulcanized fibers are a little less than half as heavy as sheet aluminum of the same thickness. Hard sheet rubber or ebonite and celluloid have practically the same density as the vulcanized fibers.

From these considerations we see that ordinary woven fabrics of cotton, either plain or treated with rubber or oil varnishes, must be given the first ranks as probably best suited of all available materials for kite surfaces. They are relatively inexpensive and can be had in a great variety of grades or weights.

Framing materials for kites must be chosen from among comparatively a few substances. Two or three different sorts of wood, aluminum, and steel make up the list. The material best adapted to a given use will often be determined by the kind of strain to which it is subjected.

(*a.*) *Tensile strength.*—A slender piece of steel wire, for example, is quite powerless to resist either flexure or compression, but no other substance compares with it in resisting tension. The tempered steel pianoforte wire employed for flying our kites resists breaking by tension at the rate of over 350,000 pounds per square inch. The same weight of aluminum of the very strongest quality would be broken by a strain of about 188,000 pounds. Aside from the difficulty of grasping it wood is also an excellent material to resist tension. Selected specimens from the strongest woods will sustain 220,000 pounds, whereas the same weight of fine tempered steel will sustain 350,000 pounds. Wood subjected to tension is thus seen to be superior to aluminum, weight for weight. These comparisons are drawn between the very finest specimens of the several materials. Their respective merits stand in much the same relation, however, when we take the average specimens. Fine grades of ordinary steel for structural purposes possess a tensile strength ranging between 100,000 and 150,000 pounds per square inch. The same weight of the better grades of rolled aluminum bars sustain only about 80,000 pounds.

(*b.*) *Crushing strength.*—Steel is about eleven and a half times as heavy as ash and hickory, and about eleven times the weight of white oak, weight for weight. These woods, under compression, crush with strains of about 69,000, 77,000, and 103,000 pounds, respectively; similarly the light woods, white pine and spruce, crush at about 80,000 pounds. Aluminum, therefore, is strikingly inferior to ordinary steel and hickory, and is practically on a par with pine and spruce, at least as far as general strength is concerned, while the woods are probably superior as regards elasticity. Under tension woods are equal to the best grades of steel of tensile strength exceeding 150,000 pounds per square inch. Wood, however, can not be practically employed to advantage under tension.

These general comparisons of strength are instructive and very important, but we must also take into account some other factors upon which the suitability of a given material depends. While steel is so eminently superior to all other materials for light and strong construction, it can not be easily and cheaply procured in the appropriate forms nor in the small sizes required for use in the construction of kites of the ordinary dimensions. Even were steel of the desired form available, its use in small frames would prove troublesome and inconvenient, on account of the constructional difficulties in securely uniting and framing parts together when formed probably of tubes with very thin walls. For kites of very large size, however, steel is undoubtedly the lightest and strongest material available for the framework, while for kites of the ordinary sizes there is probably nothing so light and strong, so inexpensive and easily procured, or so readily worked into almost any form of framework as the ordinary grades of white pine and spruce. Bamboo is very light, strong, and elastic, but its application is seriously limited by its peculiar form, which admits of little or no variation without impairing the strength of the material.

The foregoing considerations leave little room for question as to which materials are best suited in general for kite construction. The weight and strength of the materials mentioned above are summarized in Table VIII.

The relative strength of the several materials is computed, with reference to their weight as compared with that of steel. Thus, if the tensile strength of steel is 100,000 pounds per square inch of cross section, then the tensile strength of a piece of aluminum of the larger cross section necessary to preserve the same length and *weight*, rated at 28,000 pounds tensile strength per square inch, will be 81,000 pounds. The sectional area of the aluminum bar will be 2.89 square inches.

Every designer of kites who wishes to attack his problem in a scientific and engineering manner will find a fund of valuable additional information concerning "The materials of æronautical engineering" in an article under this title by Prof. R. H. Thurston, of Cornell University, published in the Proceedings of the International Conference on Ærial Navigation, Chicago, 1893.

TABLE VIII.—*Weight and relative strength of materials.*

Material.	Weight, pounds.	Relative strength.	
		Tension.	Compression.
	Per sq. ft.	*Pounds.*	*Pounds.*
Silk	.0084		
Nainsook	.0126		
Lonsdale cambric	.0187		
Muslin	.0220		
Light silk balloon fabric (for models)	.0076		
Light cotton balloon fabric	.0218		
Regular balloon fabric, cotton	.0420		
Sheet aluminum 0.01 inch thick	.1414		
Sheet steel 0.01 inch thick	.408		
Aluminum wire gauze, fine	.094		
Aluminum wire gauze, heavy	.250		
Vulcanized, fiber 0.01 inch thick	.065		
Hard rubber, per each 0.01 inch thick.	.063		
Sheet celluloid, 0.01 inch thick	.064		
Tempered steel pianoforte wire		325,000-400,000	
Hard spring phosphor bronze wire		106,000-150,000	
Aluminum wire		87,000-188,000	
Cable laid twine		84,000-109,000	
	Per cu. ft.		
High grade steel, bars	490	100,000-150,000	
Aluminum bars	169	81,000	
Ash	43	114,000-171,000	52,000- 91,000
Hickory	43	114,000-160,000	91,000-112,000
White oak	43	114,000-	63,000- 91,000
White pine	29	51,000-127,000	51,000-101,000
Spruce	31	79,000-158,000	71,000- 95,000

NOTE.—The relative strengths in the above table were compiled from Thurston's tables.

(2) *How given materials are best employed* in the construction of kites is a very interesting point, and will next receive a brief consideration. We have already been led to the conclusion that wood (white pine or spruce) is probably the best and most available material for the frame work of kites of moderate size. The strength of a given piece of material depends very much upon the manner in which it is strained. The principal strains that are likely to occur are lateral bending and compression. Shearing and torsional strains may also exist in some cases. Comparatively slight forces are sufficient to break a stick by flexure whereas the same stick will sustain far greater forces which tend to compress it. In devising the strongest and lightest construction, we must, therefore, avoid as far as possible subjecting the material to lateral bending strains. By a well known artifice of construction, it will nearly always be practicable to substitute for large bending strains two other forces or strains. One of these will be compression, the other tension. Thus the slender stick, *A B*, Fig. 64, supported at each end, is unable alone to sustain any considerable load distributed over its length. If, however, a short column, *C*, and the tension members, *T T*, be introduced, the character of the strains are entirely changed. The stick *A B* and the column *C* will now be under compression, while *T* and *T* will be put under tension by loading, and the strength of the devise is enormously increased, as every one knows. The stick is still subjected to bending strains at points between the extremities and the foot of the column *C*, but the accumulated strains on a section and its length are both half as great as in the case of the whole bar, circumstances that contribute in still greater proportion to increase the strength.

This artifice of the truss is of unlimited application in kite construction where lightness and strength are so important. The principal strains in the frame work will by this means be compression and tension, the former sustained by wooden trusses the latter by slender wires, whose weight will generally be of very little importance. Wires of hard drawn phosphor bronze resist corrosion by moisture, etc., better than steel and will in many cases probably be preferable to steel which is very much stronger.

A wide field is open for the display of ingenuity in devising the best methods of working out the details of construction, that is, the best arranged forms of the several parts, how to conveniently and securely unite them, etc., remembering always that the frame work must possess that happy quality, uniform strength. The final solution of these difficulties can not be stated yet. The writer has endeavored to point out a few important principles and has indicated the lines along which it seems the work may best proceed, but many ingenious minds by repeated experimentation must achieve new improvements before it can be said that the best has been attained.

(Concluded in the July REVIEW.)

NOTES BY THE EDITOR.

MEXICAN CLIMATOLOGICAL DATA.

In order to extend the isobars and isotherms southward so that the students of weather, climate and storms in the United States may properly appreciate the influence of the conditions that prevail over Mexico the Editor has compiled the following table from the Boletina Mensual for April, 1896, as published by the Central Meteorological Observatory of Mexico. The data there given in metric measures have, of course, been converted into English measures. The barometric means are as given by mercurial barometers under the influence of local gravity, and therefore need reductions to standard gravity, depending upon both latitude and altitude; the influence of the latter is rather uncertain, but that of the former is well known. For the sake of conformity with the other data published in this REVIEW these corrections for local gravity have not been applied.

Mexican data for April, 1896.

Stations.	Altitude.	Mean barometer.	Mean temperature.	Relative humidity.	Precipitation.	Prevailing direction.	
						Wind.	Cloud.
	Feet.	Inch.	° F.	%	Inch.		
Aguascalientes	6,112.3						
Campeche	40.4						
Colima (Seminario)		28.27	77.9	61	0.00	ssw.	w.
Colima	1,291.7		80.2				
Culiacan	112.2						
Guadalajara (H. de B.)	5,141.2						
Guadalajara (Obs. d. Est.)	5,186.4	24.97	73.8	81	4.92	sw.	
Guanajuato	6,761.3	23.64	71.2	38	1.00	ene.	sw.
Jalapa	4,757.3	25.56	68.0	75	1.72	e.	
Lagos (Liceo Guerra)		24.13	71.1	39	0.70	ne.	sw.
Leon	5,901.0	24.28	72.5	34	0.30	*	†
Mazatlan	24.6	29.92	73.8	75	0.00	nw.	sw.
Merida	50.2	29.95	81.1	59	0.00	ese.	se.
Mexico (Obs. Cent.)	7,488.7	23.08	65.5	46	0.72	n.	sw.
Mexico (E. N. de S.)	7,480.5	23.15	64.9	51	0.43	se.	
Morelia (Seminario)	6,401.0	23.95	66.7	52	1.44	sw.	w.
Oaxaca	5,164.4	25.06	74.8	51	2.43	ese.	e.
Pabellon	6,312.4						
Pachuca	7,956.3	22.58	60.6	63	1.98	nne.	
Progreso							
Puebla (Col. d. Est.)	7,118.2						
Puebla (Col. Cat.)	7,112.0	23.37	67.5	47	1.07		
Queretaro	6,069.7	24.16	70.3	46	0.20	e.	
Real del Monte (E. de H.)	9,095.2						
Saltillo (Col. S. Juan)	5,376.7	24.82	69.1	61	3.03	ssw.	n.
San Luis Potosi	6,201.9	24.10	69.3	51	0.68	e.	w.
Silao	6,063.1						
Tacambaro							
Tacubaya (Obs. Nac.)	7,620.2	22.95	63.7	51	0.70	nw.	
Tampico (Hos. Mil.)							
Tehuacan	5,152.8						
Toluca	8,612.4	21.92	62.4	49	1.19	wsw.	se.
Trejo (Hac. Silao, Gto.)					3.59		
Trinidad (near Leon)	6,010.1						
Veracruz	47.9						
Zacatecas	8,015.2	22.54	67.6	34	0.00	sw.	sw.
Zapotlan (Seminario)	5,124.8	25.05	73.4		0.54	sw.	w.

* Wsw. and ssw. † Sw. and e.

Mexican data for May, 1896.

Stations.	Altitude.	Mean barometer.	Mean temperature.	Relative humidity.	Precipitation.	Prevailing direction.	
						Wind.	Cloud.
	Feet.	Inch.	° F.	%	Inch.		
Aguascalientes	6,112.3						
Campeche	40.4						
Colima (Seminario)	1,291.7	28.26	80.4	63	0.94	ssw.	w.
Colima	1,291.7		82.2				
Culiacan	112.2						
Guadalajara (H. de B.)	5,141.2						
Guadalajara (Obs. d. Est.)	5,188.0						
Guanajuato	6,761.3	23.66	72.7	36	0.72	ene.	e.
Jalapa	4,757.3	25.53	71.4	75	2.97	nnw.	
Lagos (Liceo Guerra)	6,274.5						
Leon	5,901.0	24.27	76.1	31	0.28	*	†
Mazatlan	24.6	29.89	77.7	78	0.00	w.	sw.
Merida	50.2	29.88	85.1	60	1.12	ese.	e.
Mexico (Obs. Cent.)	7,488.7	23.07	67.6	47	0.47	n.	‡
Mexico (E. N. de S.)	7,480.5	23.05	67.6	50	0.46	se.	
Morelia (Seminario)	6,401.0	23.94	69.6	50	0.48	s.	ne.
Oaxaca	5,164.4	25.05	77.5	53	2.69	se.	ne.
Pabellon	6,312.4						
Pachuca	7,956.3	22.58	63.3	59	0.41	ne.	
Progreso							
Puebla (Col. d. Est.)	7,118.2						
Puebla (Col. Cat.)	7,112.0	23.37	69.6	54	3.99		
Queretaro	3,069.7	24.17	72.1	47	0.37	e.	
Real d. Monte (E. de H.)	9,095.2						
Saltillo (Col. S. Juan)	5,376.7	24.85	76.5	53	1.93	n.	sw.
San Luis Potosi	6,201.9	24.11	73.0	49	0.59	e.	w.
Silao		24.18	76.1	60	0.10	sw.	ne.
Tacambaro							
Tacubaya (Obs. Nac.)	7,620.2						
Tampico (Hos. Mil.)							
Tehuacan	5,152.8						
Toluca	8,612.4	21.91	62.8	45	0.34	wsw.	ne.
Trejo (Hac. Silao, Gto.)							
Trinidad (near Leon)	6,010.1						
Veracruz	47.9	29.94	82.9	76	0.83	se.	se.
Zacatecas	8,015.2	22.54	69.8	35	0.18	w.	e.
Zapotlan (Seminario)	5,124.8						

* W. and wsw. † N., e., and ne. ‡ Ne. and nw.

KITES, BALLOONS, AND CLOUDS.

The excellent series of investigations bearing on the theory and practice of flying kites for meteorological purposes now being published in the MONTHLY WEATHER REVIEW will, we hope, stimulate many others to enter this fascinating and important field of work. Kite flying was apparently first practised for meteorological purposes in the United States by Benjamin Franklin, 1752. Then came a long interval up to the work done by the Kite Club of Philadelphia in 1837, as referred to by Espy, and again a long interval until Mr. Eddy began his work at Bayonne in 1890; although, perhaps in justice to himself, the Editor may remark that in July, 1876, having for the first and only time in his life a chance to spend a week on the Jersey coast, he then flew kites at Ocean Beach and Asbury Park in order to determine the depth of the sea breeze, and had the pleasure of seeing the kite which had been borne landward by the sea breeze soon reach the upper return current and be borne seaward by it. (See Preparatory Studies, p. 92.)

Mr. McAdie's experiments of 1885 and 1892 at Blue Hill in using the balloon for studies in atmospheric electricity, and especially the work done by him and Mr. Potter in Washington in 1894 and 1895, were promptly followed by encouraging action on the part of the Chief of the Weather Bureau, and in his first publication, Professor Moore expressed his intention to prosecute explorations in the upper air by all possible means. The excellent results thus far attained by Professor Marvin are, we hope, but an earnest of the future work at Washington.

Chart VI. Kite Experiments at the Weather Bureau.

Fig. 57.

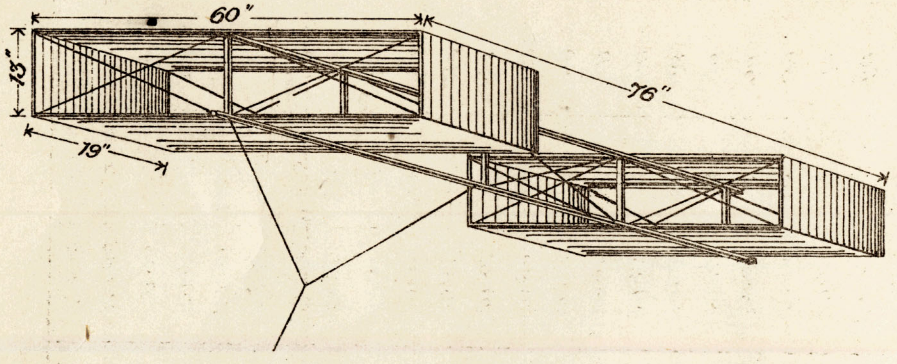


Fig. 58.

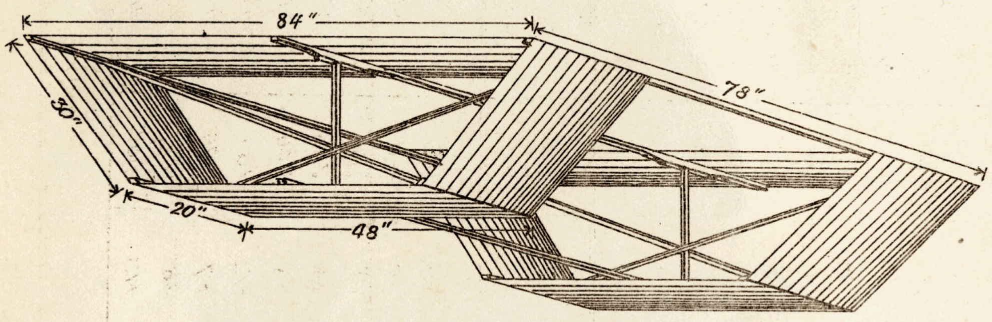
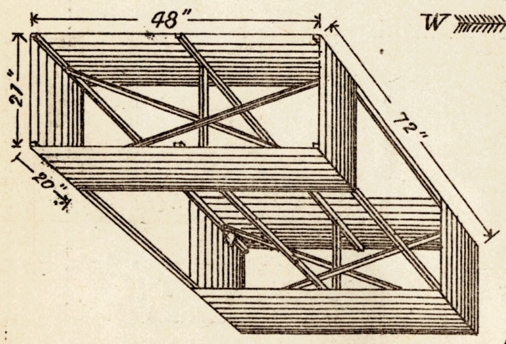


Fig. 59.



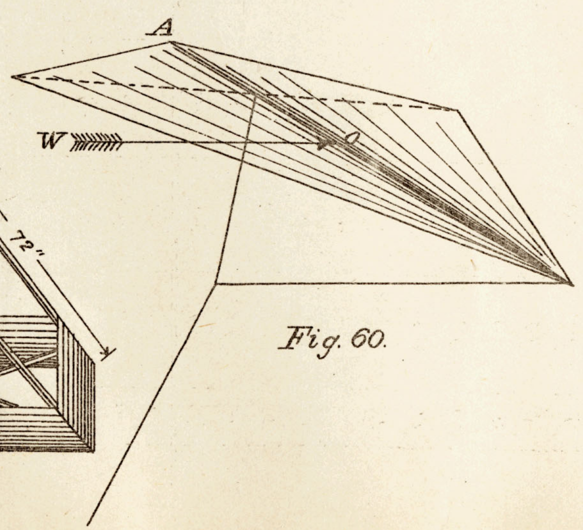


Fig. 60.

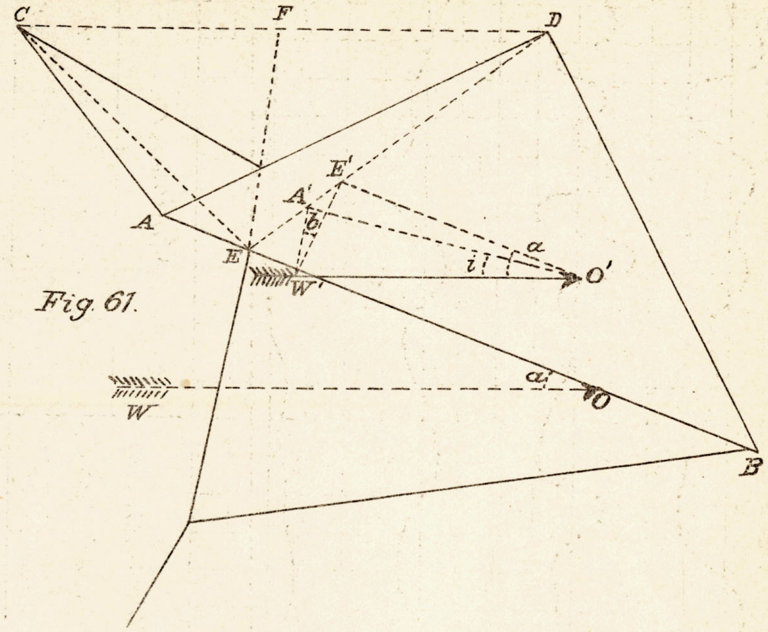


Fig. 61.

Fig. 62.

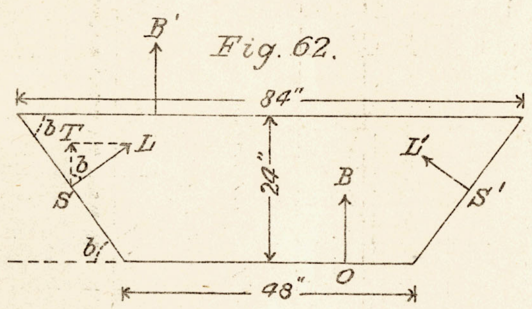


Fig. 63.

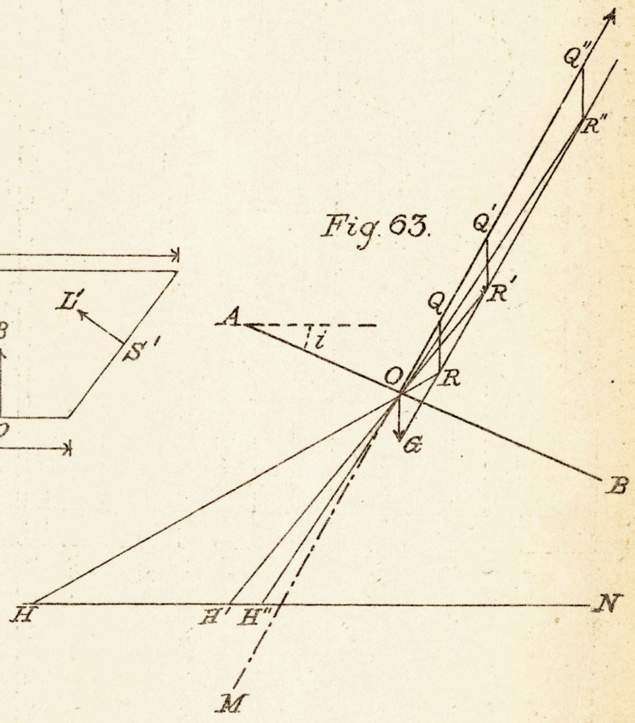


Fig. 64.